

# LANDSCAPE AS A SUPPORT FOR BIODIVERSITY: THE *ARRIBAS DO DOURO* CASE STUDY (INTERNATIONAL DOURO NATURAL PARK, NE PORTUGAL)

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**Abstract:** The fluvial canyon of the international Douro and Águeda rivers (NE Portugal-Spain border) supports a relevant natural and cultural heritage, which led to its recent integration in the portuguese conservation system - the International Douro Natural Park (IDNP). The spectacular steep cliffs, regionally named *Arribas do Douro*, are the major landscape feature of the region. They were developed during the incision of the Douro River and its tributaries on the Iberian Meseta, crosscutting granitic and metasedimentary terranes under the control of the fracture network. The landscape reflects the stream capture of the Tertiary Douro Basin towards the Atlantic by an active Quaternary down cutting. This geological setting provides one of the most important nesting habitat in Europe for vultures, eagles and black storks. The floristic heritage found on the rock slopes and ancient floodplains is also relevant. Evidence of the close relationship with the geological characteristics is also given by the millenary human occupation of the abrupt slopes, profiting from the microclimatic conditions for the production of wine, olive and almond. In conclusion, the *Arribas do Douro* landscapes have a relevant geological heritage and provide the support for the IDNP biodiversity. Therefore, the nature conservation policies must take this strong linkage into account.

## INTRODUCTION

In 1998, Portugal assigned the status of Natural Park to the deep valleys of the international Douro and Águeda rivers - the International Douro Natural Park (IDNP) - in the Portuguese-Spanish border, north-eastern Portugal (Fig. 1.a). The 851 km<sup>2</sup> of the park include 130 km of these international rivers and a narrow contiguous area of the old peneplain landscape known as Iberian Meseta. The establishment of this park was due to the high relevance of the geomorphology, wildlife, natural flora and cultural heritage.

The biotic richness of the area and its association with important geological features are the two main natural aspects for IDNP management. In spite of that, the IDNP geological heritage has not yet been object of a global inventory and characterisation. Since 2001, a three-year research project is under development, aiming to improve the IDNP geological knowledge and to create scientific instruments as a support for the sustainable management of the resources (Dias and Brilha, 2002).

The holistic approach to conceive Earth heritage conservation integrating several contexts such as landscapes, habitat type and traditional land use was already discussed by several authors (for instance, Larwood and Prosser, 1998; Erikstad, 1999). The IDNP is an example of how sustainable management of protected areas could be better attained if all aspects of nature conservation are considered, as Schelhas (2001) states. This type of management also increases the protected areas relevance in environmental education (Biderman and Bosak, 1997).

The main aim of this paper is to show how a particular geological setting influenced biodiversity in International Douro Natural Park and to reinforce that nature conservation policy must be implemented having this strong linkage in consideration.

## GEOLOGICAL SETTING

The IDNP is located in one of the most complex geological areas of the Central Iberian Zone (CIZ), having a diversified and tectonically imbricate geology (Carvalhosa, 1959; Silva and Ribeiro, 1994; Pereira, 2000). It is dominated by a sequence of autochthonous units largely covering the geological scale, from the Neoproterozoic to the Cenozoic, and a sequence of allochthonous units that belong to the nappes front of the Morais Massif. These successions include the Precambrian Massif of Miranda do Douro, one of the rare evidences of the pre-Variscan basement in CIZ, as well as a great diversity of Hercynian granitic rocks.

## LANDSCAPE EVOLUTION

The Iberian Meseta is a large geomorphological unity, developed in granitic and metasedimentary rocks of the Hesperian Massif. The Meseta is an old and extensive plain, one of the largest in Europe, located about 700 m above sea level.

The Douro River, in the IDNP area, carved an entrenched valley cutting the high plateau (Fig. 1.b). The channel orientation and a great number of incised meanders are clearly controlled by the fracture network (Fig. 1.c). The major fractures are late hercynian and some of them were reacti-

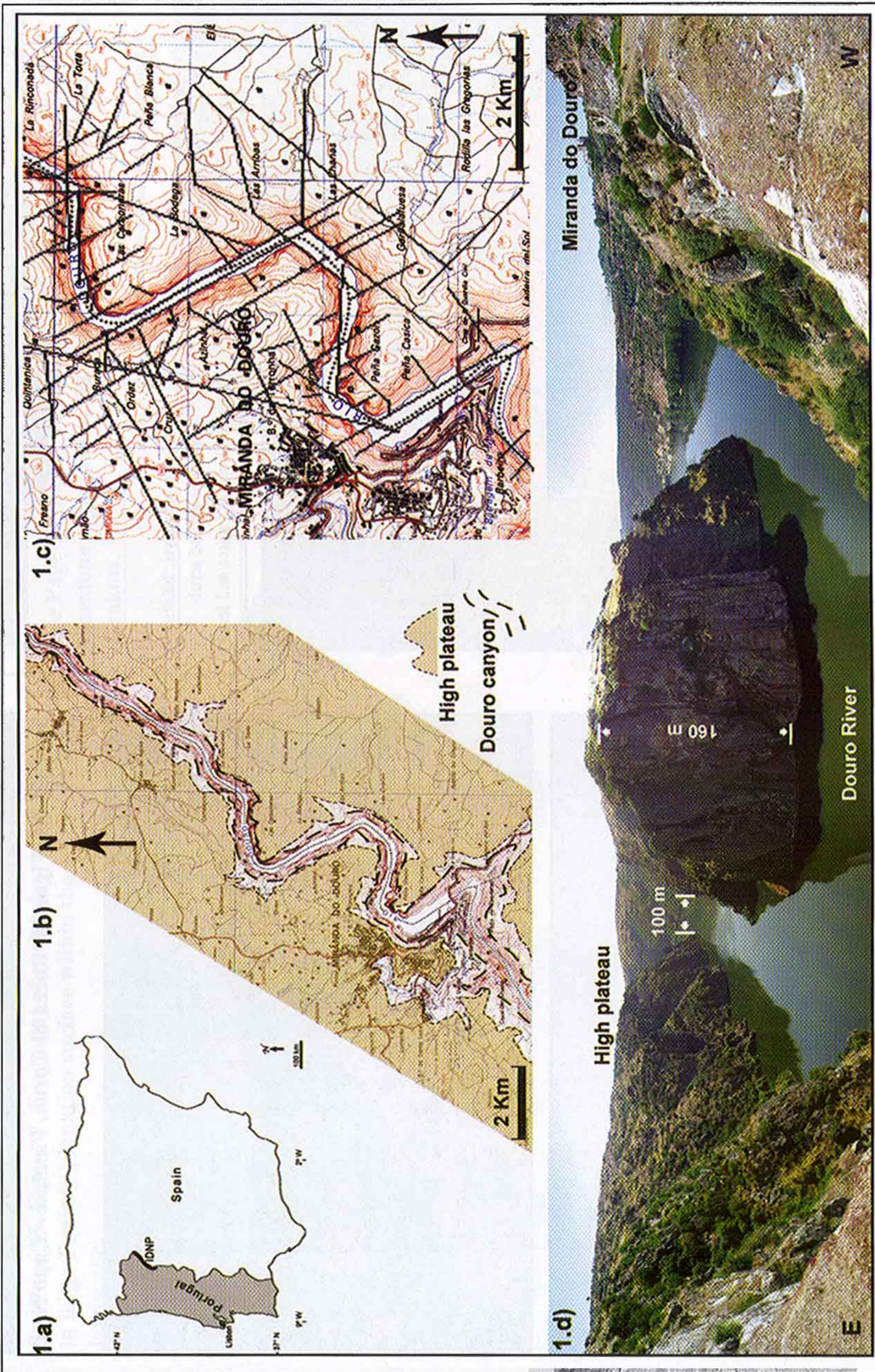


Figure 1. Location of the International Douro Natural Park (IDNP, NE Portugal) (1.a). Geomorphological features (1.b,d) and fracture pattern (1.c) at the Miranda do Douro region (northern IDNP).

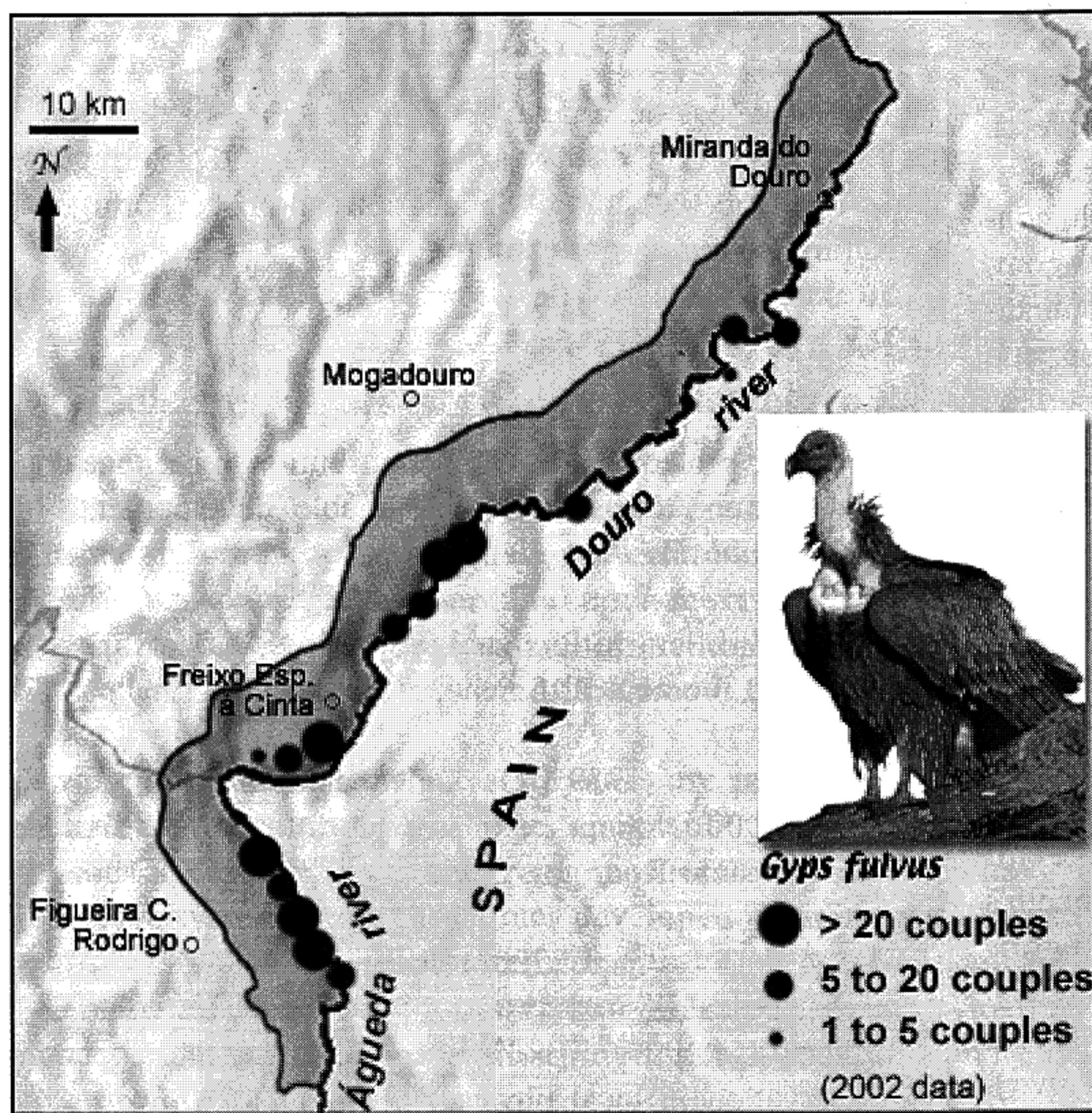


Figure 2. Distribution of the Griffon Vulture (*Gyps fulvus*) in the International Douro Natural Park (dark shaded area).

Table I - Vertebrates found in the IDNP area.

	Total species Numbers	Total species number in Portugal (%)
Mammals	29	42%
Birds	150	37%
Reptiles	17	59%
Amphibians	11	65%
Fishes	14	33%
Total	221	50%

vated during the Alpine orogeny. The main orientation of the international Douro course is influenced by the NNE-SSW to NE-SW fractures. Locally, the valley is under the control of NW-SE, N-S, and E-W fractures, which promote the occurrence of incised meanders.

The narrow Douro valley is canyon-type. The spectacular canyon escarpments are regionally known as *Arribas do Douro* (Fig. 1.d). The river flows 200-300 m below the plain surface. The longitudinal profile of the Douro River is very abrupt, descending from 550 m to 130 m in only 90 km inside the IDNP. These geomorphological features allowed the building of six hydroelectric dams.

The present day Douro River represents a snapshot of an ancient fluvial evolution. The former Douro basin has been considered an intracontinental basin of cratonic type. Its western boundary is a relatively flat hercynian border that remained essentially passive during the Cenozoic (Santisban et al. 1996). Probably until Zanclean, fluvial drainage in NE Portugal was endorheic, towards the Douro

basin. The major hydrographical reorganization in the area occurred during Miocene-Pliocene times. In the Late Pliocene, an important fluvial network was already captured by the fluvial pattern that drained towards the Atlantic. Therefore the endorheic Tertiary Douro Basin turned into a generally exorheic basin by the end of the Pliocene (Pereira et al. 2000). The *Arribas do Douro* landscape reflects an active Quaternary downcutting of the basement, associated with the incision of the Douro River and its tributaries. This process is controlled by the Atlantic base level and by the fracture network.

## CLIMATE AND LANDSCAPE

The present day geomorphological features induce different climatic characteristics between the high plain and the valley. Climate in the valley has Mediterranean characteristics, being more prominent to the south, at Freixo de Espada à Cinta - Barca de Alva region, and is more humid and softer than in the plateau. The mean annual temperature in the valley is 15°C, with few days below 0°C in the winter.

These particular climate conditions allowed the establishment along the Douro and Águeda rivers of fauna and flora typical of southern latitudes. Sun radiation, air temperature and moisture conditions inside the canyon change as function of the side slopes height, their orientation and declivity, thus supporting an enormous variety of floristic communities. Another evidence of the close relationship between geological, geomorphological, and climatic characteristics is given by the millenary human occupation of the slopes taking advantage of a particular microclimate for the production of wine, olive, almond and orange.

## LANDFORMS AND BIODIVERSITY

Inside park boundaries, there are rich communities of fauna and flora, with important populations of endangered species such as cliff nesting birds. There are 221 species of vertebrates including Mammals, Birds, Reptiles, Amphibians and Fishes, representing 50% of the total number of species in Portugal and an important number of Iberian species (Table I).

As already shown, two complementary geomorphological units characterize the IDNP: the high plateau and the canyons. A large diversity of landforms occurs on the canyon sidewalls, such as vertical cliffs, steep dipping slopes, some with inverse dip, convex surfaces, domes, turrets, castellated blocks, angular blocks, split blocks, foliation slabs, wedges, rock caves, cliff-foot caves, clefts and rocky steps. This diversity of morphological features, as well as the nearby high plain, offers a diverse flora and fauna habitat, which are important for the ecological balance of this park.

The plateau is an ecological mosaic of woods, groves,

corn-lands, and other plantations. This diversity allows the existence of insect species and wild mammals, as the roe deer, the wild boar, the wolf, the otter (in the main rivers), bats, and also reptiles and amphibians. There are also autochthonous species of cattle and sheep, which contribute for the nourishment of the eagles and vultures communities. The plateau around the main valleys is dominated by pastureland, sclerophyllous scrub, *Quercus* sp. and *Juniperus oxicedrus* woodland.

Several species of animals and plants have their main habitat inside the canyon. The geological and ecological features are a benefit for cliff nesting species, in particular for the eighteen bird species, which are the IDNP emblematic group, that build their nests in colonies on rocky clefts, caves and steps (Monteiro, 1998). Only considering birds, there are 300 couples of Griffon Vulture (*Gyps fulvus*) (Fig. 2), 70 couples of Egyptian Vulture (*Neophron percnopterus*, elected for the park symbol), 18 couples of Golden Eagle (*Aquila chrysaetus*), 14 couples of Bonelli's Eagle (*Hieraaetus fasciatus*), 10 couples of Peregrine Falcon (*Falco peregrinus*), 15 couples of Eagle Owl (*Bubo bubo*), 15 couples of Black Stork (*Ciconia nigra*) and more than 100 couples of Chough (*Pyrrhocorax pyrrhocorax*). *Arribas do Douro* is one of the most important areas in Europe for this group of species. The bare rocks are also inhabited by floristic species growing in fractures and clefts, some of them millenary. In the canyon several species are frequently found, such as the alder, the arbutus-berry, the ash-tree, the juniper, the lotus-tree, the oak, the oak evergreen and also plantations of wine, olive, almond, chestnut and orange in the southern area of the park.

This rich biodiversity was responsible for the classification of this region as Site of Community Importance (SCI) and Special Protection Area (SPA).

## CONCLUSIONS

The International Douro Natural Park (IDNP) presents a richness of natural features constituting a reference in the portuguese natural park system. In this natural park the most significant geomorphological feature is the fluvial canyon of the Douro River and its tributary, the Águeda river, dissecting the high plateau of the Iberian Meseta and crossing various geological terranes where a large diversity of landforms are exposed. This relevant geosite, locally known as *Arribas do Douro*, the IDNP *ex-libris*, conditioned the establishment of many ecosystems. This is an ecological region of great value, due to a large number of species, particularly rupicolous birds, sedentary and migratory, which search this area for nesting. The valley/plateau landscape features provide the support for the food chain equilibrium of the various ecosystems.

Due to the strong links between IDNP geodiversity and biodiversity, conservation policies must be undertaken together. This holistic approach is very important for park management and, consequently, for environmental education.

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